

# Monitoring and Forecasting Cyanobacterial Blooms for Public Health Protection and Response

NASA - Decision Support through Earth Science  
NNH08ZDA001N-Decisions

Rick Stumpf, Shelly Tomlinson, Tim Wynne, NOAA

Andy Reich, Florida Department of Health

Sonia Joseph-Joshi, Michigan Sea Grant and Center of Excellence for Great Lakes and Human Health

Juli Dyble-Bressie, NOAA Great Lakes Environmental Research Lab

Lorrie Backer, Centers for Disease Control, Environmental Health

# What is the problem with Cyanobacteria?

Cyanobacteria can produce toxins with various hazards (hepatotoxins, neurotoxins, dermatotoxins).

*Microcystis aeruginosa* produces microcystin.

WHO standard < 1 ug/L drinking water,  
< 20 ug/L recreational exposure.

Kills dogs and cattle.

Expense for drinking water supplies  
(taste, odor, filtration)

Beach posting becoming more common.

*Photo credit: Tom Archer, 2009*



*Microcystis*, credit: J. Dyble

# Team

NOAA/NOS Center for Coastal Monitoring and Assessment: *Rick Stumpf, Tim Wynne, Shelly Tomlinson*

*Overall project coordination, satellite remote sensing for detection of cyanobacteria, forecast system development, overseeing the transition of research capabilities into operations and skill assessment*

Center of Excellence for Great Lakes and Human Health (and Sea Grant): *Sonia Joseph*

*Leads the education and outreach component in the Great Lakes*

NOAA Great Lakes Environmental Research Lab : *Juli Dyble-Bressie*  
*Evaluate the ecological models for detection and forecasts and assist in field data collection*

Florida Department of Health: *Andrew Reich*

*Leads user interaction in Florida and develop plans that integrate the forecasts into response systems, and aid in identifying appropriate products*

Center for Disease Control and Prevention: *Lorraine Backer*

*To incorporate products into the HAB Illness Surveillance System (HABISS) to make them available to the user community*

# Some background: developed operational Harmful Algal Bloom Forecast System for the Gulf of Mexico

An operational system to inform the user community on the current and possible future Harmful Algal Bloom conditions

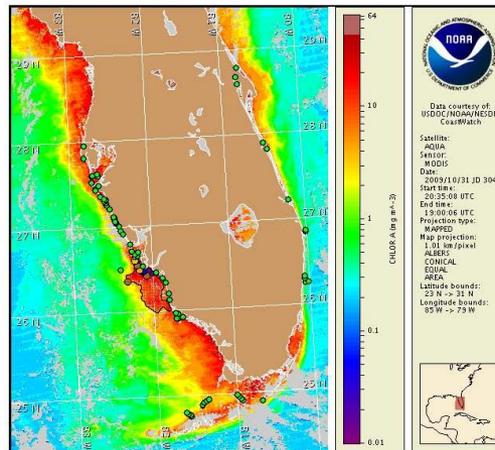
- HAB Bulletin for managers includes imagery, meteorological conditions, field data and analysis
- Web site and Conditions Report for the General Public
- Developed in cooperation with State and county agencies, citizens groups, and tourism bureaus



## Gulf of Mexico Harmful Algal Bloom Bulletin

Region: Southwest Florida  
2 November 2009

NOAA Ocean Service  
NOAA Satellites and Information Service  
NOAA National Weather Service  
Last bulletin: October 29, 2009



Satellite chlorophyll image with possible HAB areas shown by red polygon(s). Cell concentration sampling data from October 23 to 30 shown as red (high), orange (medium), yellow (low b), brown (low a), blue (very low b), purple (very low a), pink (present), and green (not present). For a list of cell count data providers and a key to the cell concentration categories, please see the HABFS bulletin guide: [http://hiresandcurrents.noaa.gov/hab/habfs\\_bulletin\\_guide.pdf](http://hiresandcurrents.noaa.gov/hab/habfs_bulletin_guide.pdf)

Please note the following restrictions on all SeaWiFS imagery derived from CoastWatch.

1. Data are restricted to civil marine applications only; i.e. federal, state, and local government use/distribution is permitted.
2. Image products may be published in newspapers. Any other publishing arrangements must receive GeoEye approval via the CoastWatch Program.

## Conditions Report

A harmful algal bloom has been identified onshore northern and central Lee County, in the Pine Island Sound/San Carlos Bay region in Lee County, and offshore southern Lee and northern Collier counties. Patchy moderate impacts are possible today through Wednesday in northern and central Lee County and in the Pine Island Sound/San Carlos Bay region in Lee County. No impacts are expected elsewhere alongshore southwest Florida today through Wednesday, November 4. Dead fish and discolored water have been reported offshore central Lee County over the past few days.

## Analysis

A harmful algal bloom has been identified onshore northern and central Lee County, in the Pine Island Sound/San Carlos Bay region in Lee County, and offshore southern Lee and northern Collier counties. Samples taken on 10/30 indicate background concentrations of *K. brevis* near the Cabbage Key area of Pine Island Sound (FWRI). Samples collected from Merwin Key and between Long Point and York Island indicate very low a and very low b concentrations, respectively (FWRI; 10/30). Low a and low b concentrations were found at Redfish Pass and Captiva Pass (FWRI; 10/30). A sample taken at Buck Key indicates medium *K. brevis* concentrations (FWRI; 10/30). Recent samples indicate that *K. brevis* is no longer present in Boca Grande Pass (FWRI; 10/30).

Recent samples in the Sanibel Island region of Lee County indicate medium *K. brevis* concentrations near the Sanibel Causeway Ramp (FWRI; 10/30) and Algiers Beach (FWRI; 10/29). Very low a and low a samples were identified in the Lighthouse Beach and Tarpon Beach areas of Sanibel Island, respectively (FWRI; 10/28).

Extensive fish kills and discolored water have been reported in central Lee County, approximately 10 miles southwest of Sanibel Island (FWRI; 10/29, 11/1). Respiratory irritation has been reported at Tarpon Bay off the north coast of Sanibel Island (MML; 11/1).

Additional samples collected alongshore Pinellas, Manatee, Charlotte, and Collier counties all indicate that *K. brevis* is not present (FWRI, MML, SCHD; 10/26-30). Samples taken offshore northern Monroe County and in the Florida Keys also indicate that *K. brevis* is not present (MML; 10/22-29). Two of numerous samples taken alongshore Sarasota County indicate background concentrations (SCHD, MML; 10/26); all other samples indicate that *K. brevis* is not present.

MODIS satellite imagery (10/31) indicates elevated to high chlorophyll levels (>7  $\mu\text{g/L}$ ) alongshore Lee and northern Collier counties. Patches of high levels of chlorophyll (>10  $\mu\text{g/L}$ ) offshore central to southern Lee County, southwest of Sanibel Island, and offshore northern Collier County are also visible. Generally, patches extend from northern Lee County (26°46'21"N 82°6'38"W) to south of Sanibel Island (26°21'30"N 82°0'41"W). Another patch of elevated to high chlorophyll (>5  $\mu\text{g/L}$ ) is visible offshore northern Collier County centered at 26°7'51"N 82°0'50"W. Continued sampling throughout this region is recommended. Elevated to high chlorophyll levels (>3  $\mu\text{g/L}$ ) are also present alongshore and offshore Pinellas County. Samples from this region did not contain *K. brevis*.



# Goals of Project

Help managers with public health and safety

Reduce cost of impact

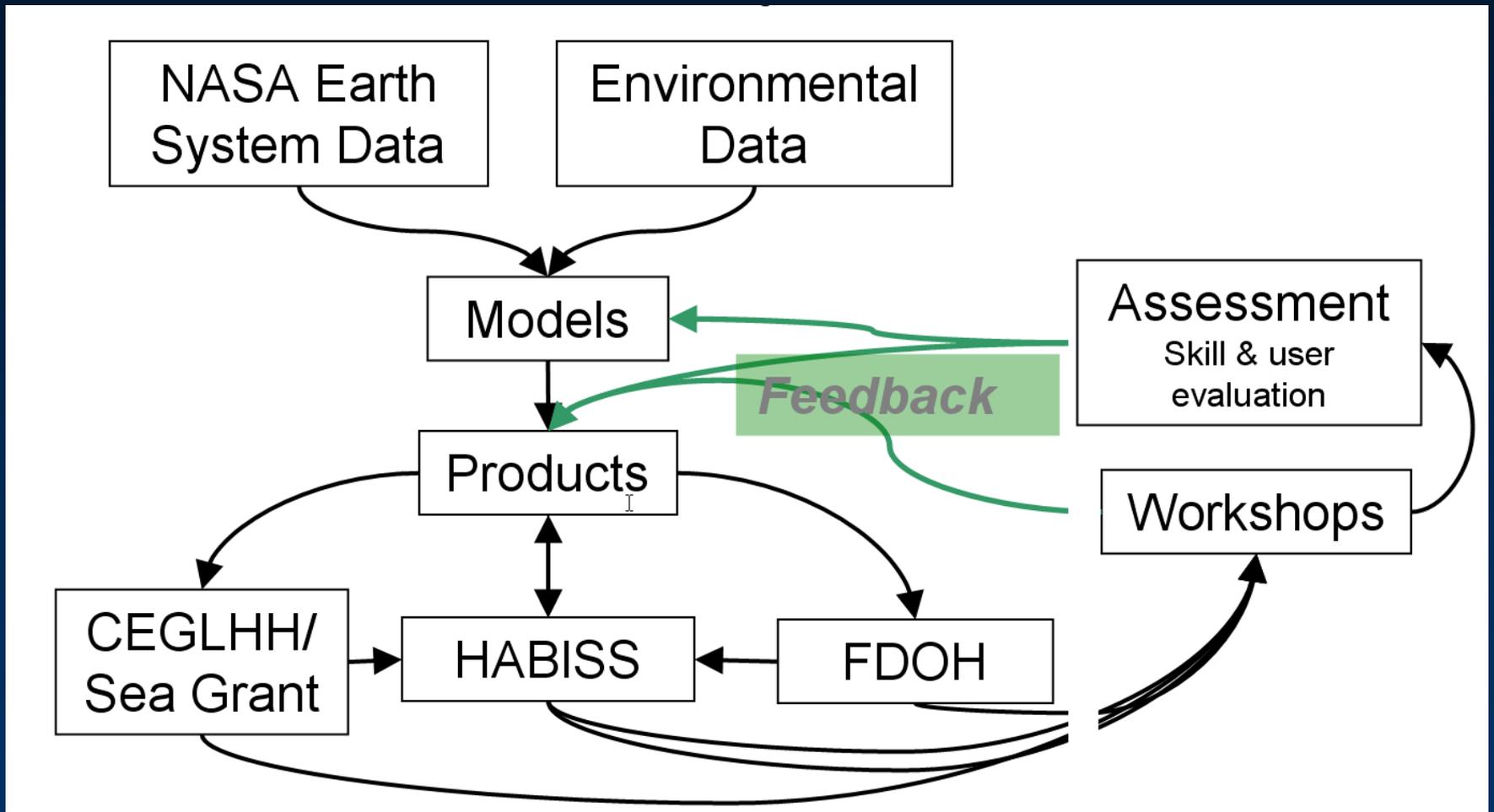
Educate the public

Reduce impacts to the public

Establish procedures for routine support and for an operational capability

*Algal foam on St Johns River  
Photo credit: Dana Morton, city of Jacksonville,  
26 July 2010*

# Cyano Management and Forecast System



## First year successes

Improved forecasts for Lake Erie:

Higher resolution, weekly analysis, 100 subscribers,

Success on locating blooms

Active engagement with Ohio and water suppliers

Examination of inland lakes

Interest by Maryland, testing Erie models in Chesapeake Bay

Products distributed to Florida and Maryland

# First Year challenges

Getting Florida & Michigan sub-contract set up (delays in Florida analyses)

Increased interest by managers in products have slowed climatological analyses.

More products, more users.

# 2010 HAB Stakeholder Workshops

- Lake Erie Beach Conference, 22 Jan  
Cuyahoga Co. Dept of Health  
met with health and natural resource mgrs
- Algal Toxin Workshop (OSU Sea Grant and Ohio EPA,  
Stone Lab, 8-9 Aug)  
instruct water supply and environmental mgrs on  
remote sensing and forecasting
- CDC HAB program, Atlanta, 29 Oct 2009  
review of capabilities with HABISS state mgrs



# Public interest

To Whom It Concerns,

July 2009

We live on Catawba Island and when we came home yesterday, the shoreline around our house smelled and the water was bright green and thick like pea soup. I've attached a photo of this phenomena as it's almost impossible to believe. Obviously we stayed out of the water. But this has us greatly concerned.

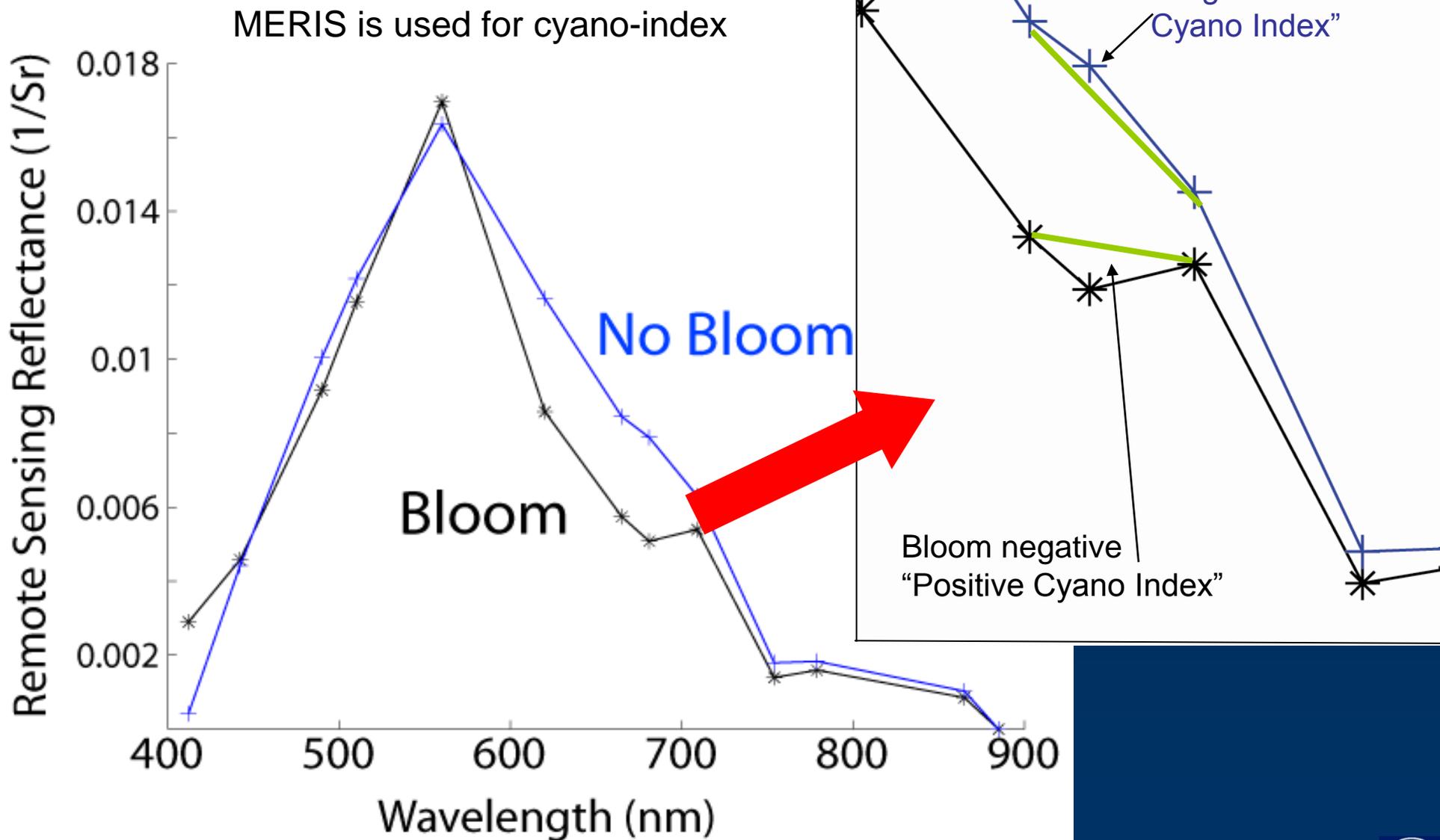
Can you please supply us with some sort of explanation, if you have one yet?



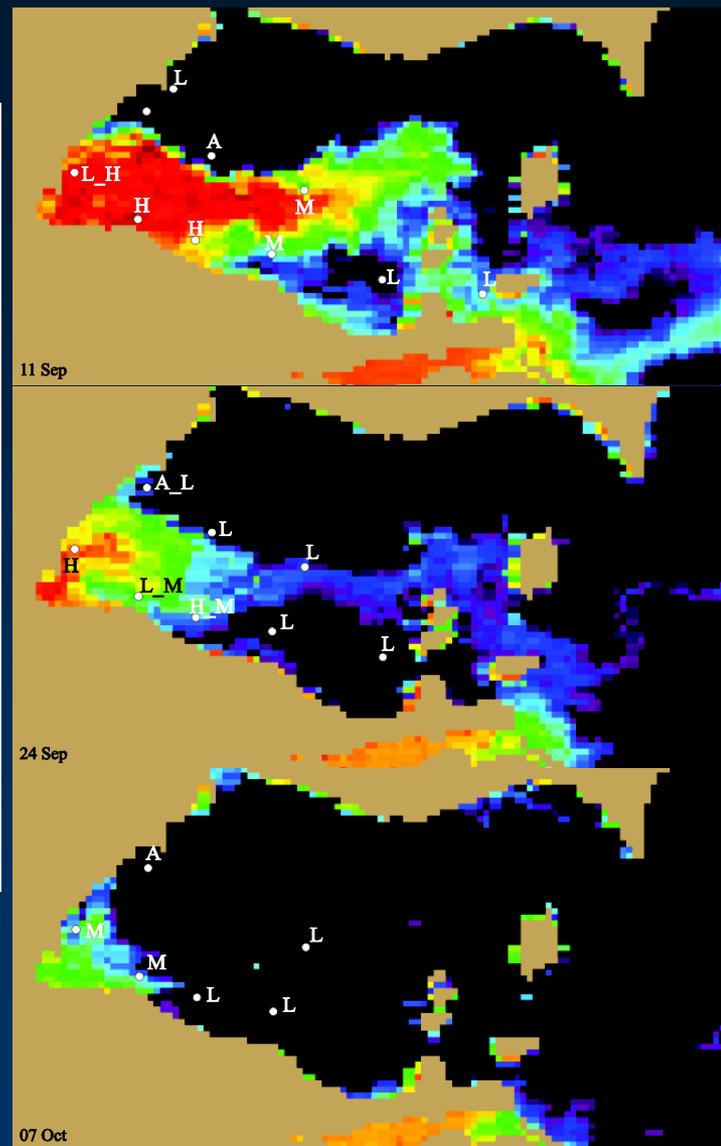
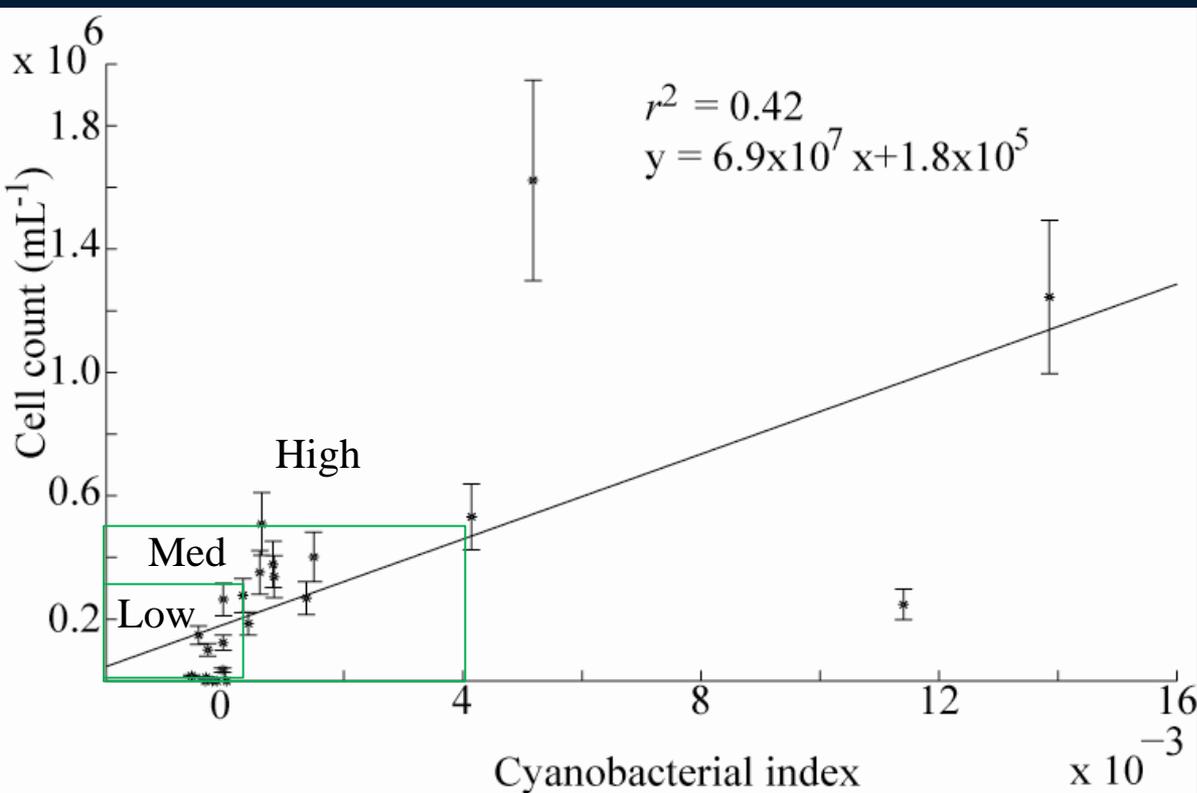
Photo credit: Diane D. Straw



# Locating blooms

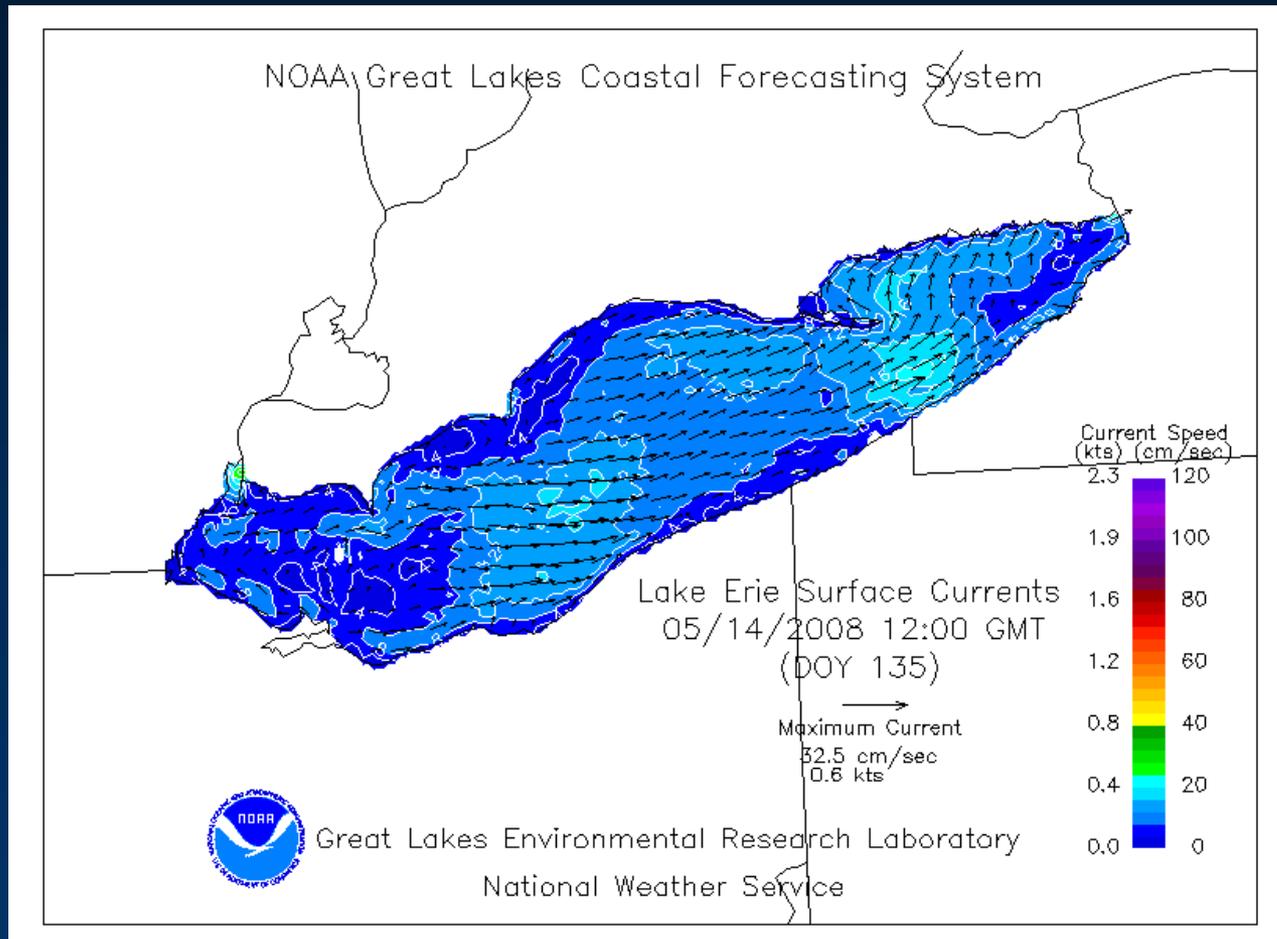


# Obtaining cell counts from satellite

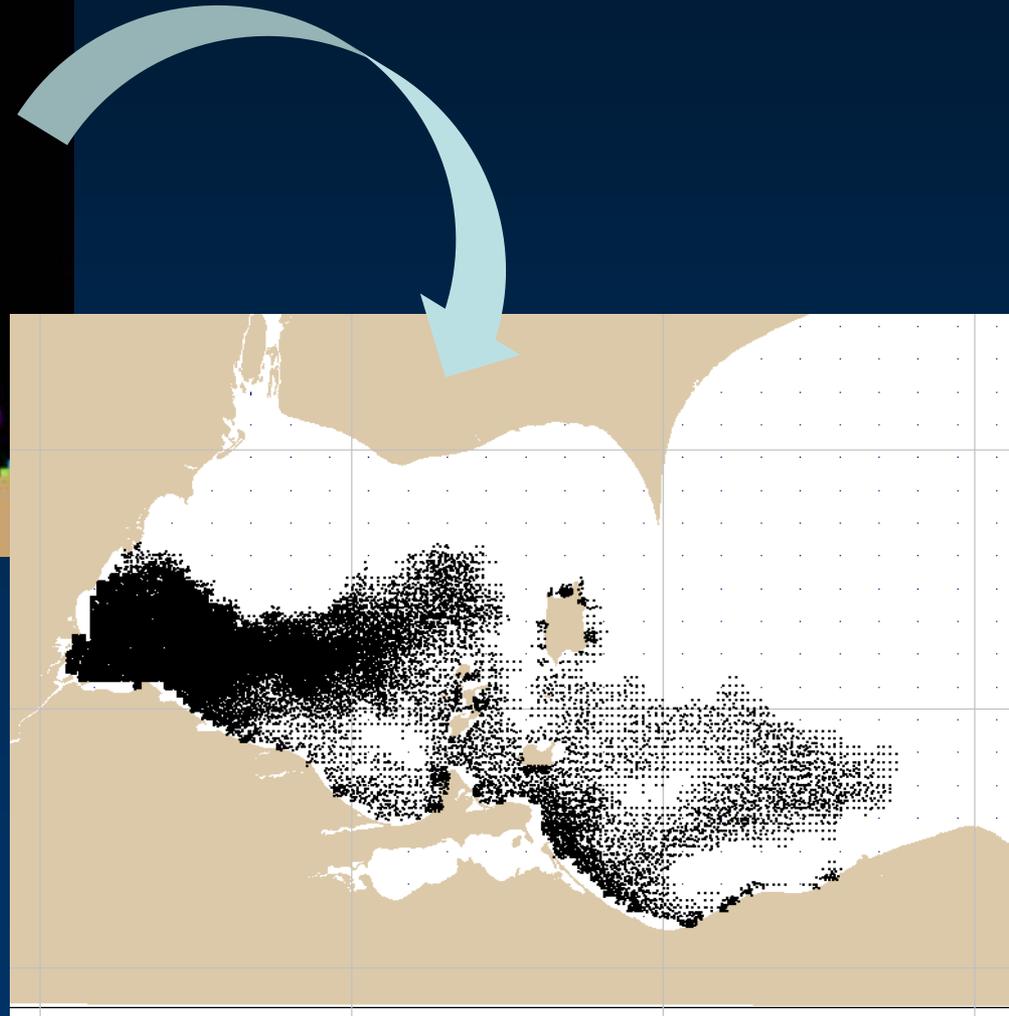
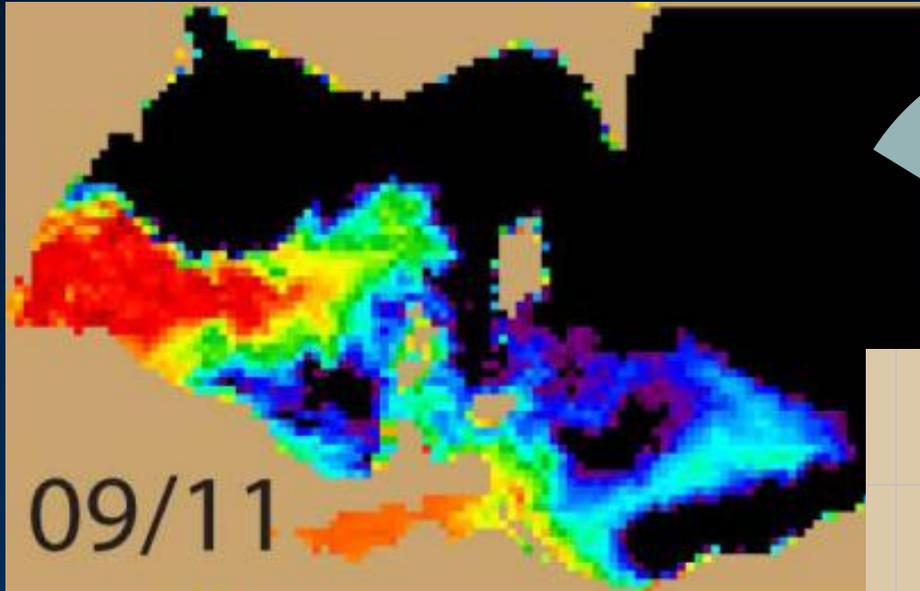


Satellite against field cell counts (now working on field radiometry)

# Great Lakes Coastal Forecasting System provides nowcast and forecast of currents



# Concentration estimated from satellite converted to particles



Particles are combined in  
GNOME with currents



## Experimental Lake Erie Harmful Algal Bloom Bulletin

2009-004

13 August 2009

National Ocean Service

Great Lakes Environmental Research Laboratory

Last bulletin: 06 August 2009

Satellite index (MERIS 2-days old)

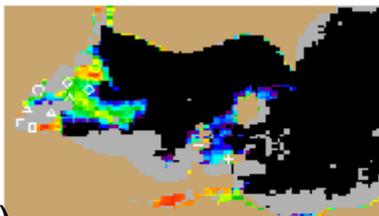


Figure 1. MERIS image from the European Space Agency. Imagery shows the spectral shape at 681 nm from August 11, where colored pixels indicate the likelihood of the last known position of the *Microcystis* spp. bloom (with red being the highest concentration). *Microcystis* spp. abundance data from August 11 shown as white squares (very high), circles (high), diamonds (medium), triangles (low), + (very low) and X (not present). Please note: Colored pixels in Sandusky Bay are due to a mixed bloom dominated by *Planktothrix* spp.

Nowcast to today

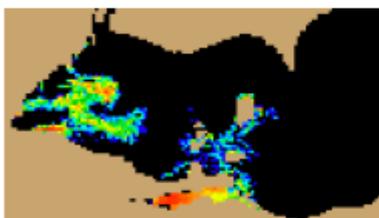


Figure 2. Nowcast position of *Microcystis* spp. bloom for August 13 using GLCFS modeled currents to move the bloom from the August 11 image. Please note: Colored pixels in Sandusky Bay are due to a mixed bloom dominated by *Planktothrix* spp.

Forecast to 3 days

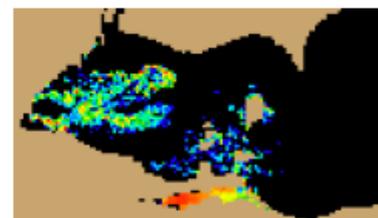


Figure 3. Forecast position of *Microcystis* spp. for August 16 using GLCFS modeled currents to move the bloom from August 11 image. Please note: Colored pixels in Sandusky Bay are due to a mixed bloom dominated by *Planktothrix* spp.

**Conditions:** A *Microcystis* spp. bloom has been identified in Maumee Bay and the adjacent waters to the northeast. The bloom may be visible from the shore, or near shore areas outside of Maumee Bay. A mixed cyanobacterial bloom is also present in Sandusky Bay. Moderate taste and odor issues have been observed and may continue to persist as a result of the bloom.

**Analysis:** The *Microcystis* spp. bloom in Western Lake Erie continues to persist and increase in both area and concentration. The bloom in Sandusky Bay is a mixed bloom dominated by *Planktothrix* spp. Wind stress is expected to be low for the next several days, which may intensify the bloom. The bloom is forecasted to remain relatively stationary, with a tendency to drift slightly to the NE. The feature present around the South Bass Islands has been identified as having very low concentrations of *Microcystis*. The feature has spread in area since last week's bulletin and may continue to spread. It should be noted that clouds covered Maumee Bay (gray pixels in the observed imagery). As a result of these clouds, the nowcast and forecast show no (or very little) concentration in Maumee Bay.

-Wynne, Dyble, Meredith

Please note:

- MERIS imagery was distributed by the NOAA CoastWatch Program and provided by the European Space Agency
- Cell counts were collected by the Great Lakes Environmental Research Laboratory
- The wind data is available through the National Data Buoy Center and the National Weather Service
- Modeled currents were provided through the Great Lakes Coastal Forecasting System

# Lake Erie nowcast/forecast (also Ohio detection)



**Experimental**  
**Lake Erie Harmful Algal Bloom Bulletin**  
2010-009  
05 August 2010  
National Ocean Service  
Great Lakes Environmental Research Laboratory  
Last bulletin: 29 July 2010

*Conditions:* A bloom of *Microcystis* cyanobacteria has been identified from Maumee Bay to Catawba Island.

*Analysis:* Imagery and field samples indicate very high concentrations of *Microcystis* in Maumee Bay and north along the coast to La Plaisance Bay. Very high concentrations of *Microcystis* are also present east of Catawba Island. Models indicate an eastward offshore transport of the bloom area north of Maumee Bay. Additionally, no transport is predicted for the area east of Catawba Island. Winds are forecasted to decrease into the weekend.

-Briggs

Satellite  
index

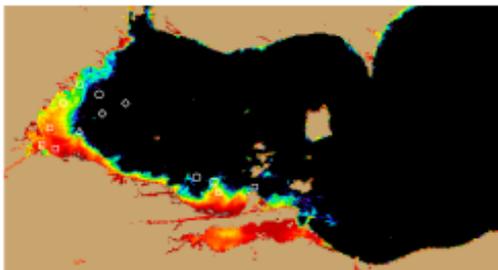


Figure 1. MERIS image from the European Space Agency. Imagery shows the spectral shape at 681 nm from July 30, where colored pixels indicate the likelihood of the last known position of the *Microcystis* spp. bloom (with red being the highest concentration). *Microcystis* spp. abundance data from shown as white squares (very high), circles (high), diamonds (medium), triangles (low), + (very low) and X (not present).

Nowcast  
to today

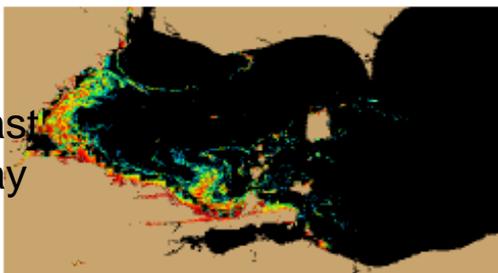


Figure 2. Nowcast position of *Microcystis* spp. bloom for August 05 using GLCFS modeled currents to move the bloom from the July 30 image.

Forecast  
to 3 days

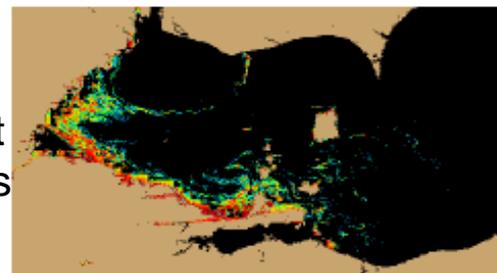


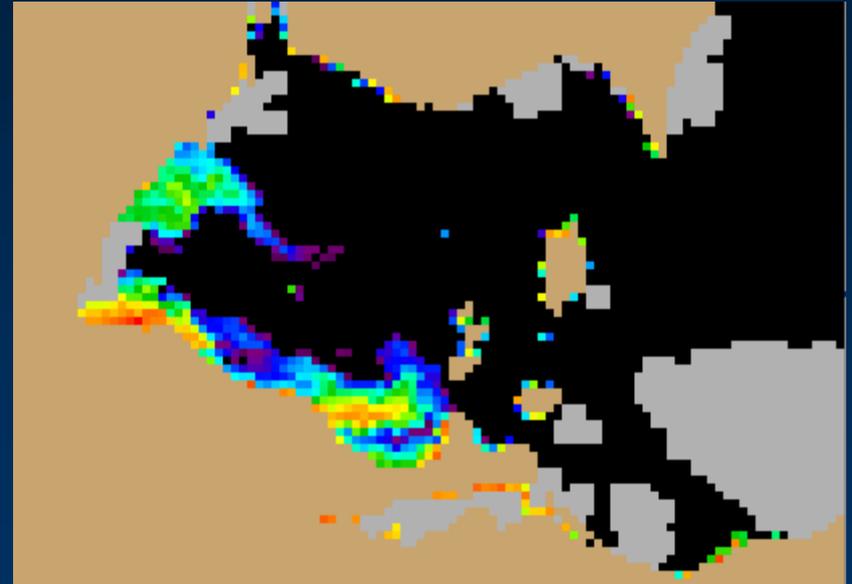
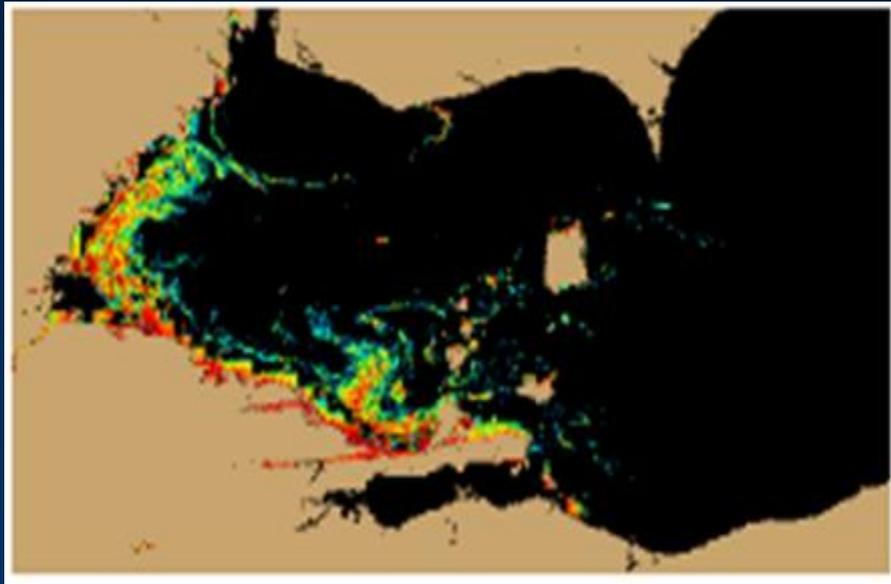
Figure 3. Forecast position of *Microcystis* spp. for August 08 using GLCFS modeled currents to move the bloom from July 30 image.

Please note:

- MERIS imagery was distributed by the NOAA CoastWatch Program and provided by the European Space Agency
- [http://www.glerl.noaa.gov/mo/Centers/HABS/lake\\_erie\\_hab/lake\\_erie\\_hab.html](http://www.glerl.noaa.gov/mo/Centers/HABS/lake_erie_hab/lake_erie_hab.html)
- Cell counts were collected by the Great Lakes Environmental Research Laboratory
- The wind data is available through the National Data Buoy Center and the National Weather Service
- Modeled currents were provided through the Great Lakes Coastal Forecasting System



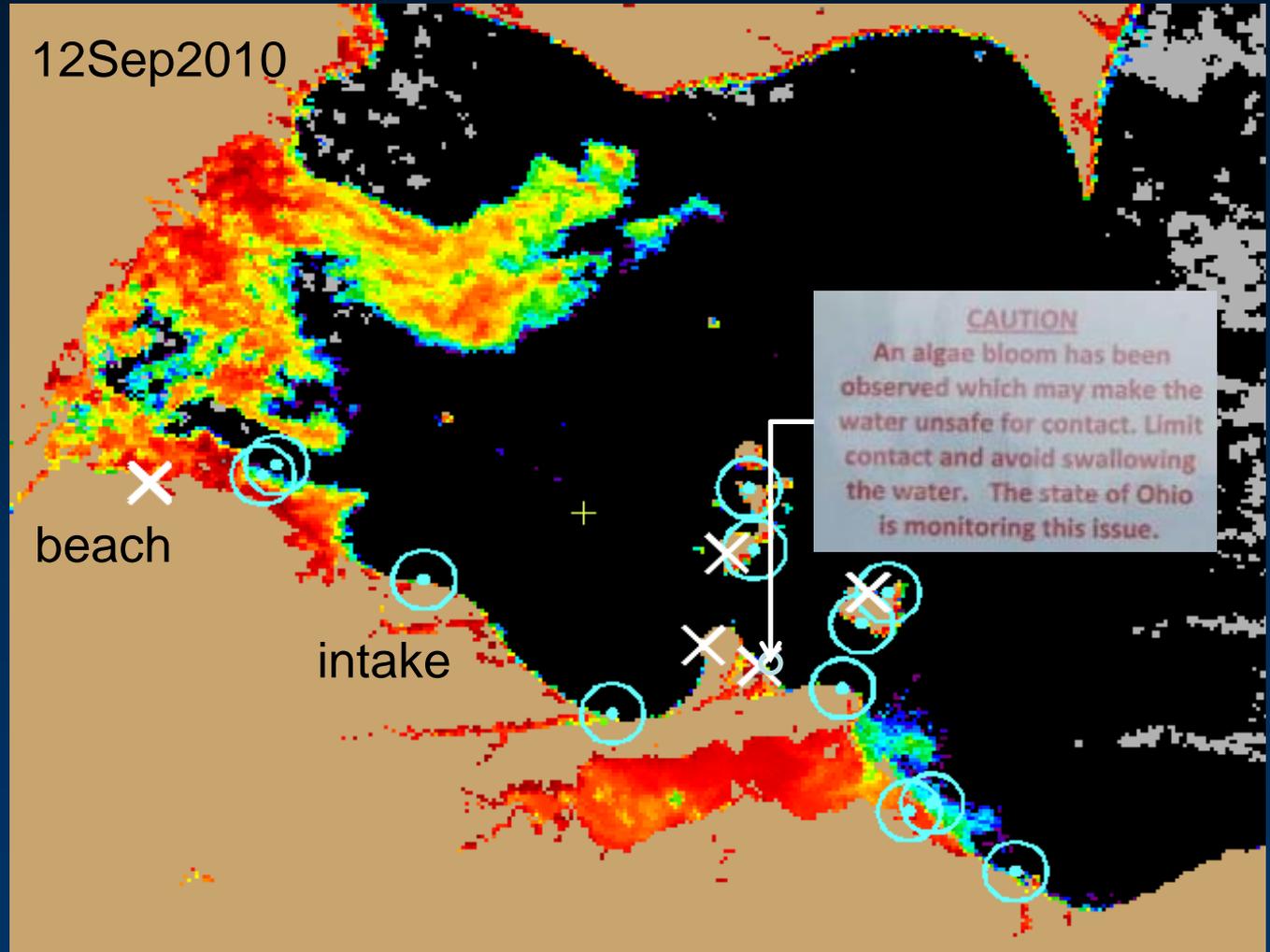
# Comparison of modelled CI for Aug 05 (based on July 29) and observed Aug 06, 2010



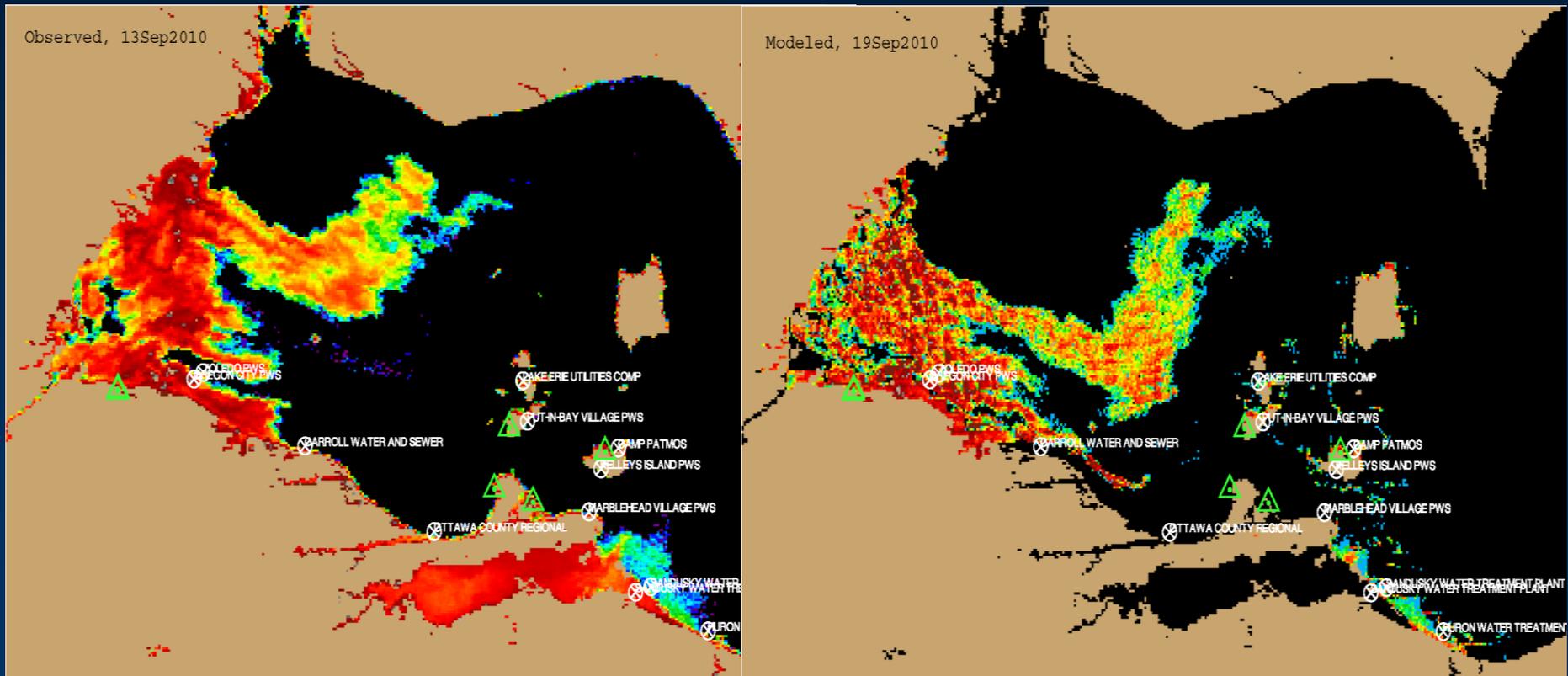
# Intakes and Park Beaches.

12 Aug: first beach closure on Lake Erie in years

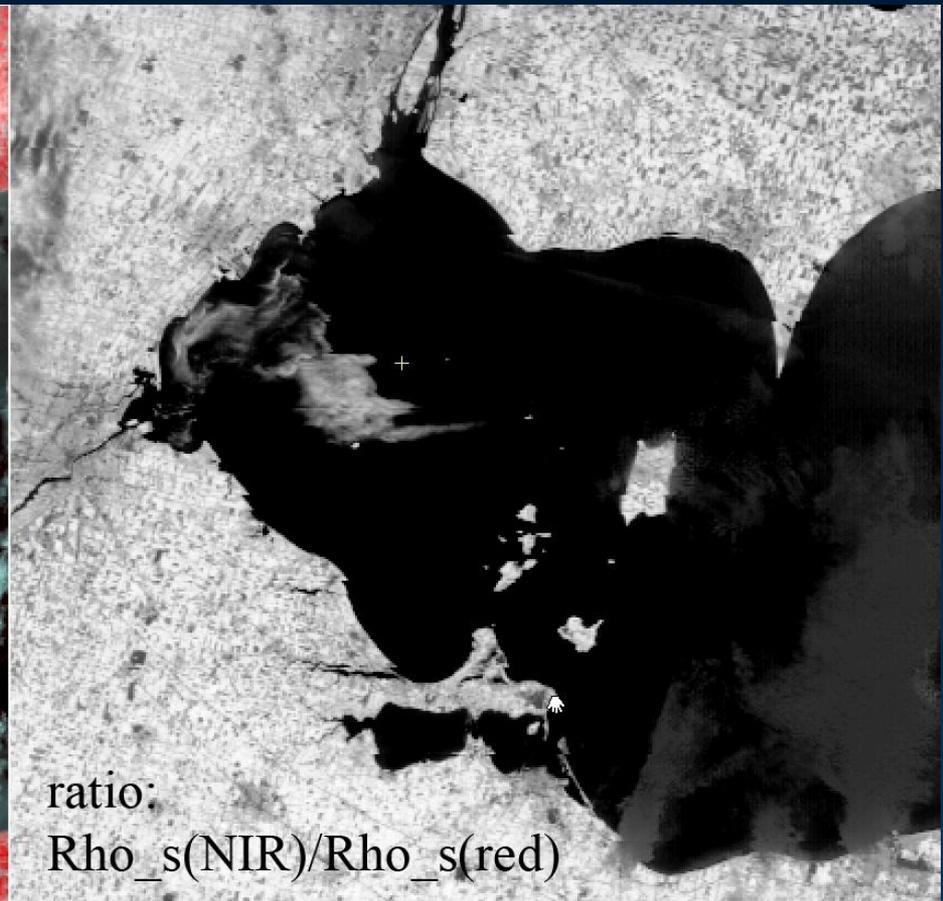
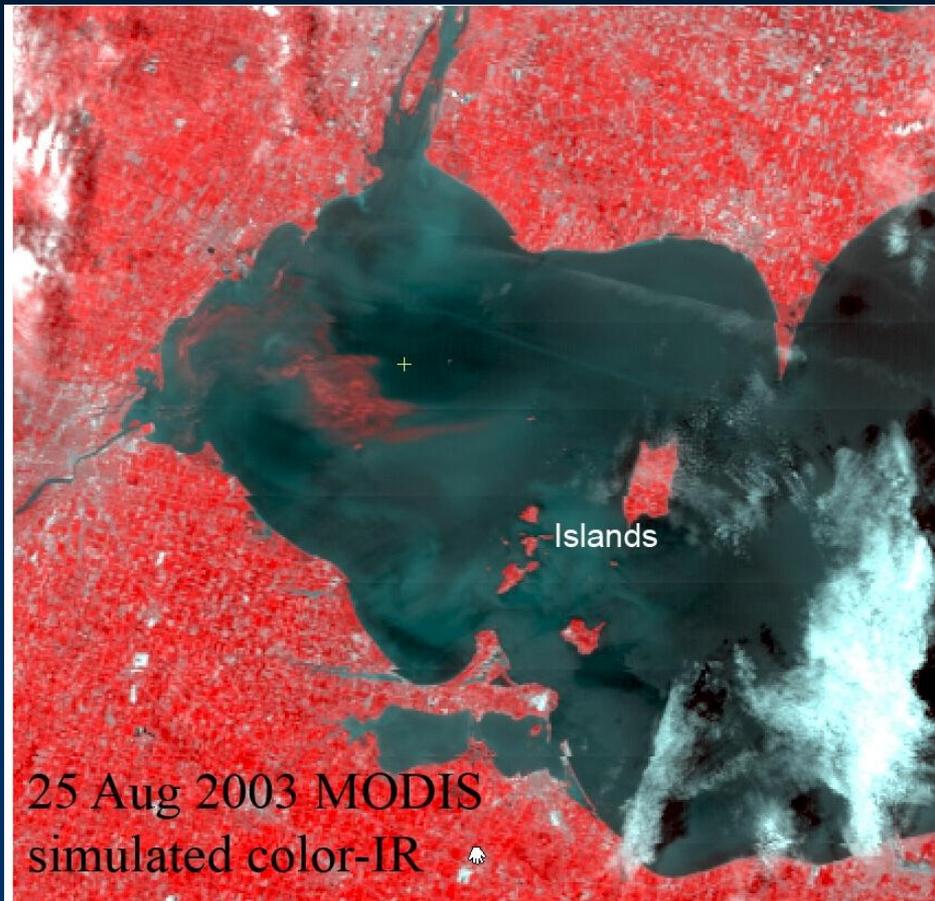
Supporting  
Ohio EPA  
and Ohio  
DNR



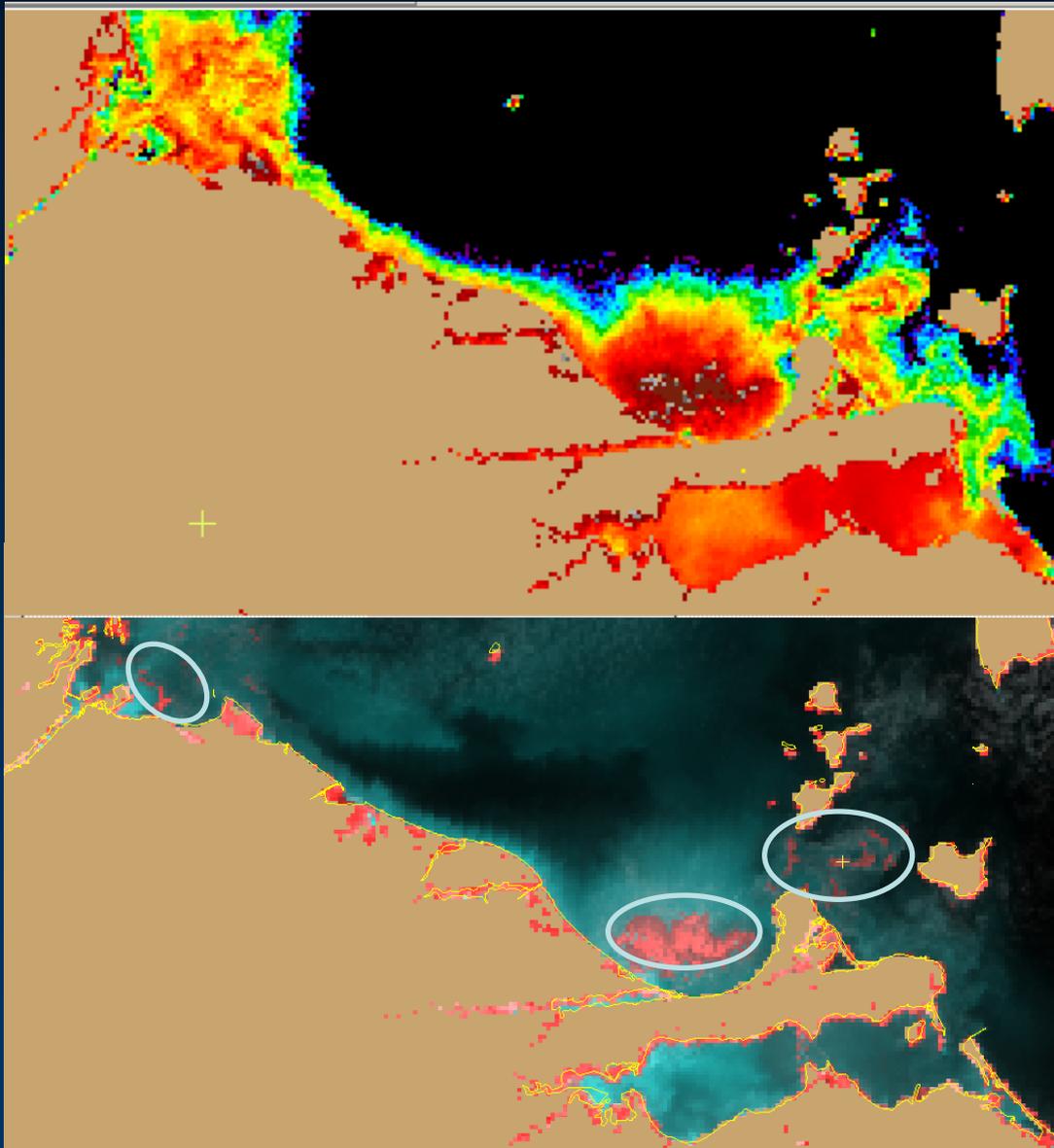
# Forecasting impact at intakes



# Scum detection with MODIS



# Working to quantify



27 July 2010  
Cyano-index  
from MERIS

27 July 2010,  
NIR/red fixed  
pink indicates  
scum

we see no indication of anything in the Cleveland area

# Ability to respond to public interest

Date: Friday, August 13, 2010 am

Subject: lake erie

To: [hab-glakes@noaa.gov](mailto:hab-glakes@noaa.gov)

I plan on boating in Lake Erie this weekend, probably in the Cleveland area. Is there a problem with algae right now? Is the water safe for swimming?

Thank you.

## Reply

Date: Friday, August 13, 2010 am

Subject: Re: lake erie

From: [hab-glakes@noaa.gov](mailto:hab-glakes@noaa.gov)

We see no indication of anything in the Cleveland area.

 **Experimental**  
**Lake Erie Harmful Algal Bloom Bulletin**  
2010-011  
12 August 2010  
National Ocean Service  
Great Lakes Environmental Research Laboratory  
Last bulletin: 12 August 2010

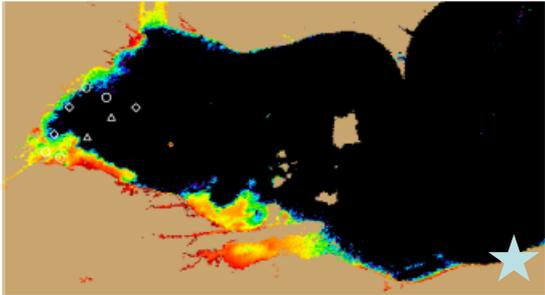


Figure 1. MERIS image from the European Space Agency. Imagery shows the spectral signature of the bloom from August 09, where colored pixels indicate the likelihood of the last known position of the bloom (with red being the highest concentration). *Microcystis* spp. abundance data from August 09 are overlaid on the image: white squares (very high), circles (high), diamonds (medium), triangles (low), + (very low). A white star is in the bottom right corner.

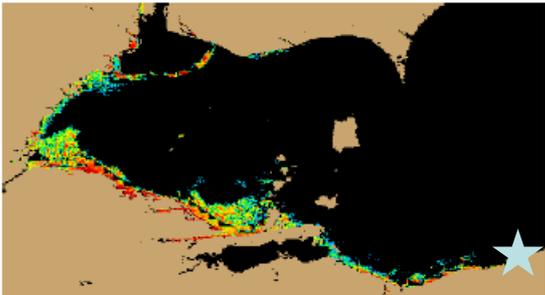


Figure 2. Nowcast position of *Microcystis* spp. bloom for August 12 using GLCFS model. The model predicts the bloom's movement and intensity changes from the August 09 image. A white star is in the bottom right corner.



# Harmful Algal Bloom Field Observation Survey

## Page One

If you are seeing a bloom, please fill out this survey and let us know details.  
Fill out as best as you can.

### 1. Sample Location: \*

### 2. GPS Location (lat, long):

### 3. Date:

### 4. Time:

### 5. Wind Direction:

### 6. Wind Strength

### 6. Wind Strength

### 7. Weather Conditions:

### 8. Water Temperature (in Fahrenheit):

### 9. Wave Height (in meters):

### 10. Secchi Depth Reading (in meters):

### 11.

	Yes	No
Rainfall within 48hrs:	<input type="checkbox"/>	<input type="checkbox"/>
Visible scum:	<input type="checkbox"/>	<input type="checkbox"/>
Health warning posted at the location:	<input type="checkbox"/>	<input type="checkbox"/>
Closure posted at location:	<input type="checkbox"/>	<input type="checkbox"/>
Complaints received about conditions at location:	<input type="checkbox"/>	<input type="checkbox"/>

### 12. Amount of Algae in Nearshore Water:

- None
- Low (1-20%)
- Moderate (21-50%)
- High (> 50%)

**13. Amount of Algae on Beach:**

- None
- Low (1-20%)
- Moderate (21-50%)
- High (> 50%)

**14. Number of People at location:**

**15. Number of birds present at location:**

**Type(s) of birds:**

**16. Domestic animals present at location:**

**Type(s) of domestic animal(s):**

**17. Litter/debris present (please give detailed description of materials present at the location):**

**18. Any additional information about this location? For example: was there visible scum of foul smelling water the previous week or day(s)?**

**19. Do you have an image of the bloom?**

If yes, please e-mail image to [hab-glakes@noaa.gov](mailto:hab-glakes@noaa.gov) with the subject including the date and location of the bloom.

- Yes
- No

Submit

0%

### Lakes with health warnings

Lakes at Dillon, Lake Hope and Lake Loramie state parks were removed yesterday from the list of lakes that have tested positive for toxic algae. The lake at Mount Gilead State Park was added to the list. There are now 15 lakes and ponds where officials fear that liver and nerve toxins produced by blue-green algae could be a health threat.

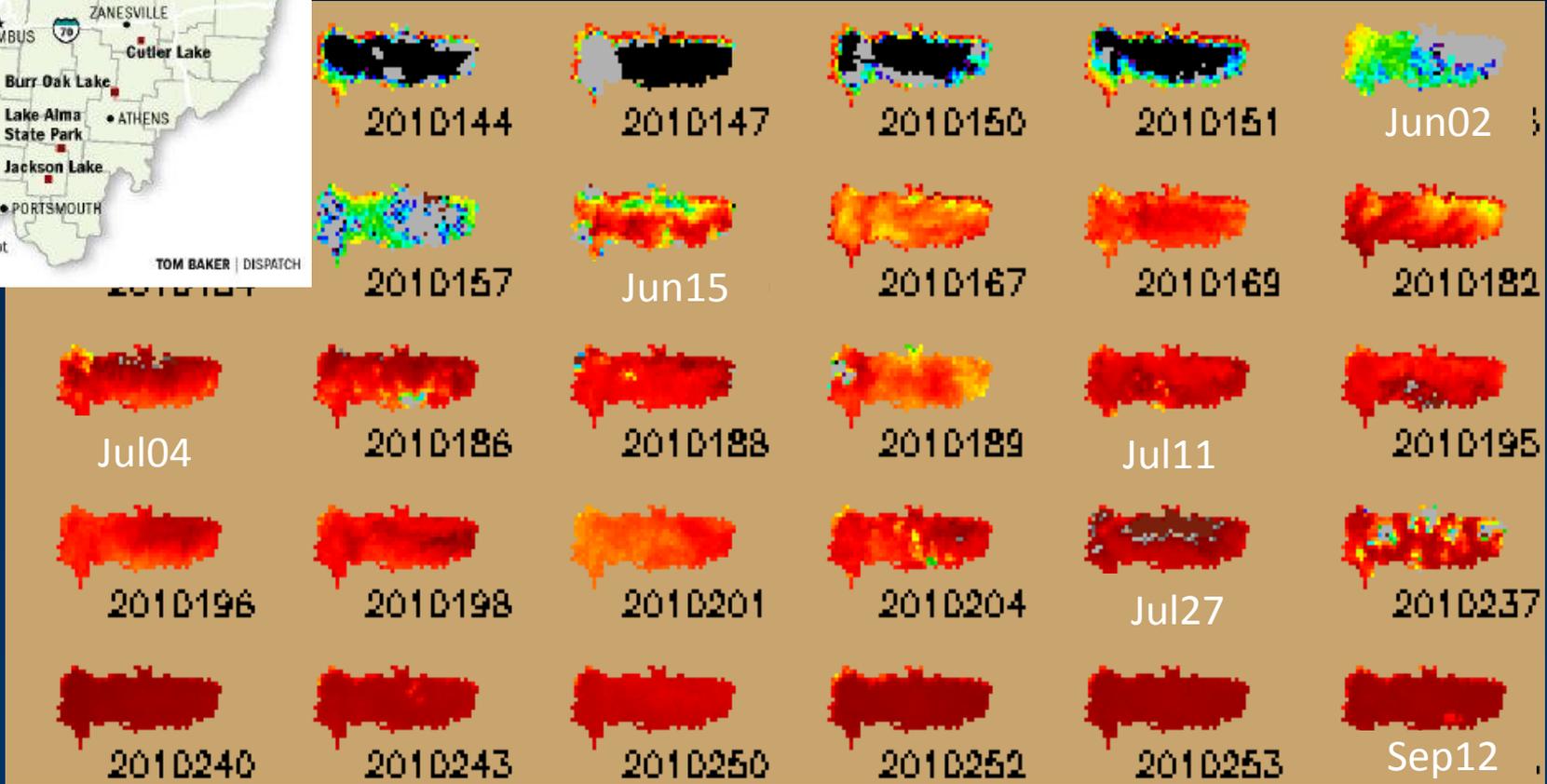


\* Bodies of water affected are not the main lakes or reservoirs.

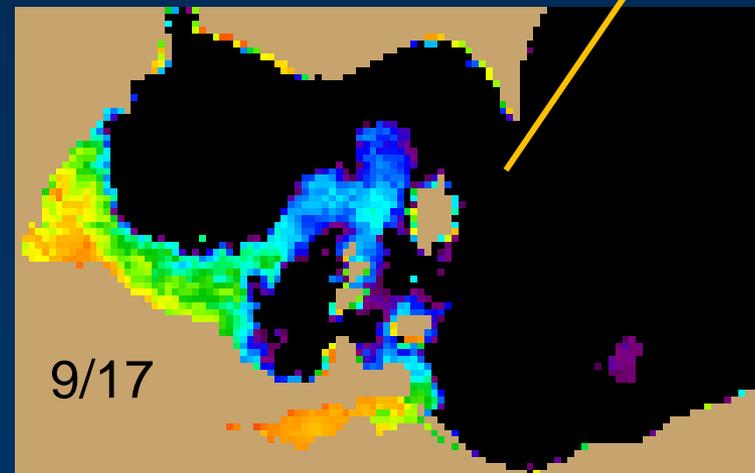
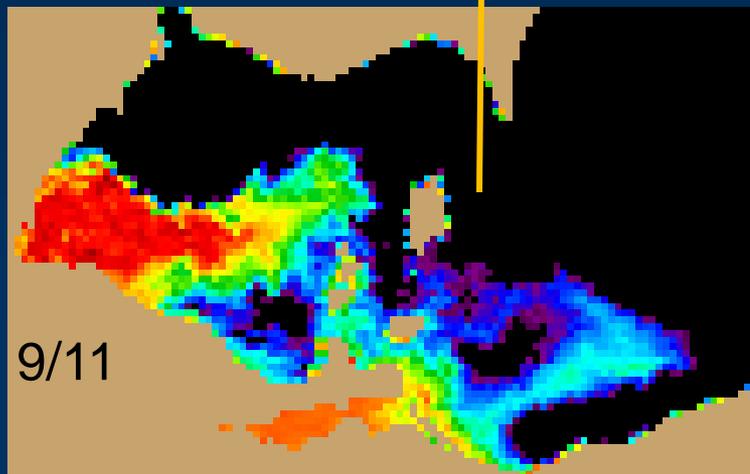
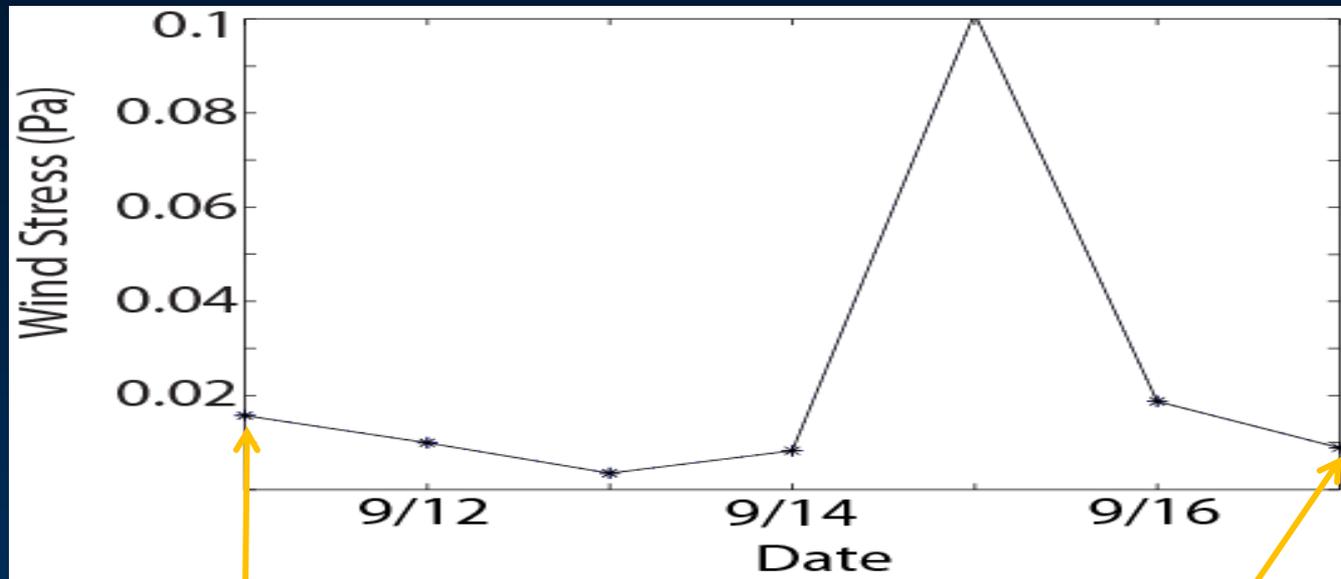
TOM BAKER | DISPATCH

# Grand Lake St Marys, Ohio largest lake in Ohio, major state issue

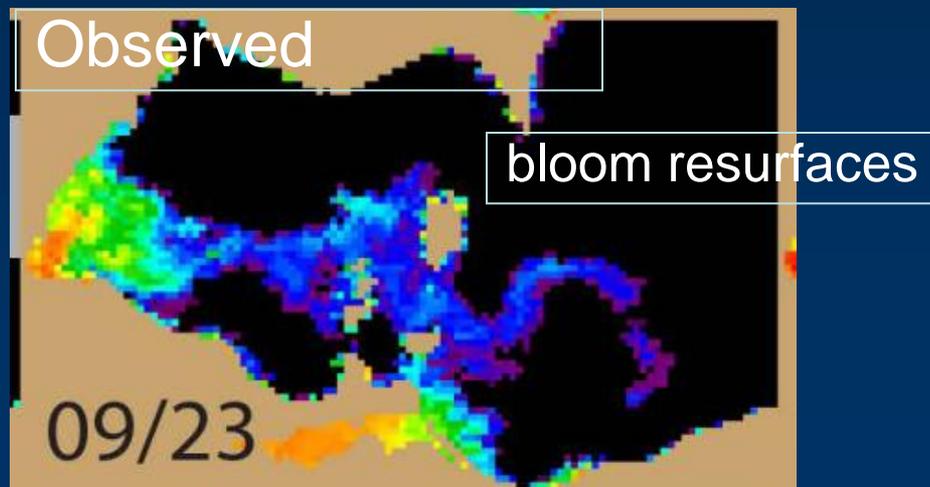
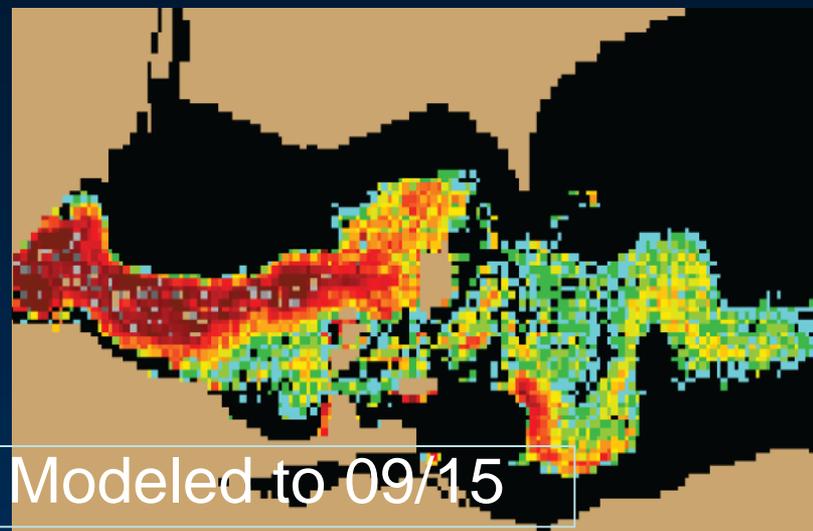
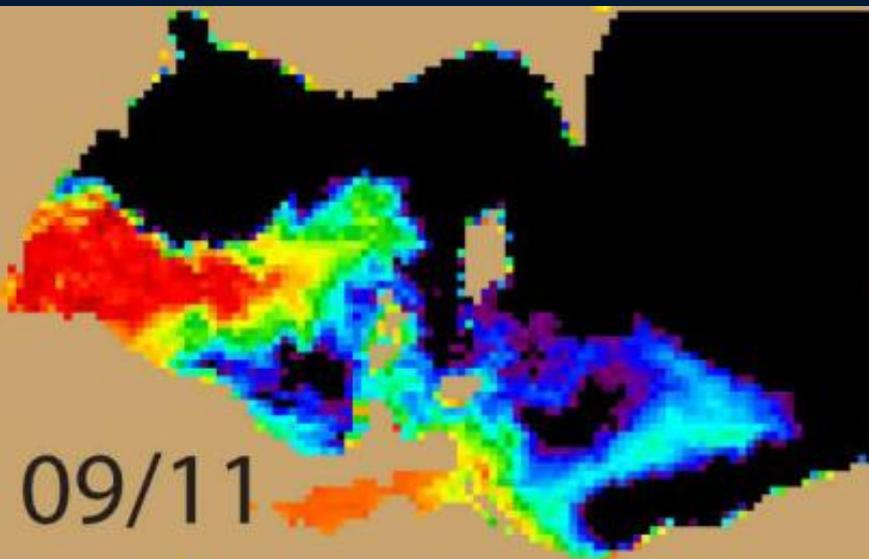
## Cyano index for this summer



# Images will need to be interpreted with winds based on Wynne et al.



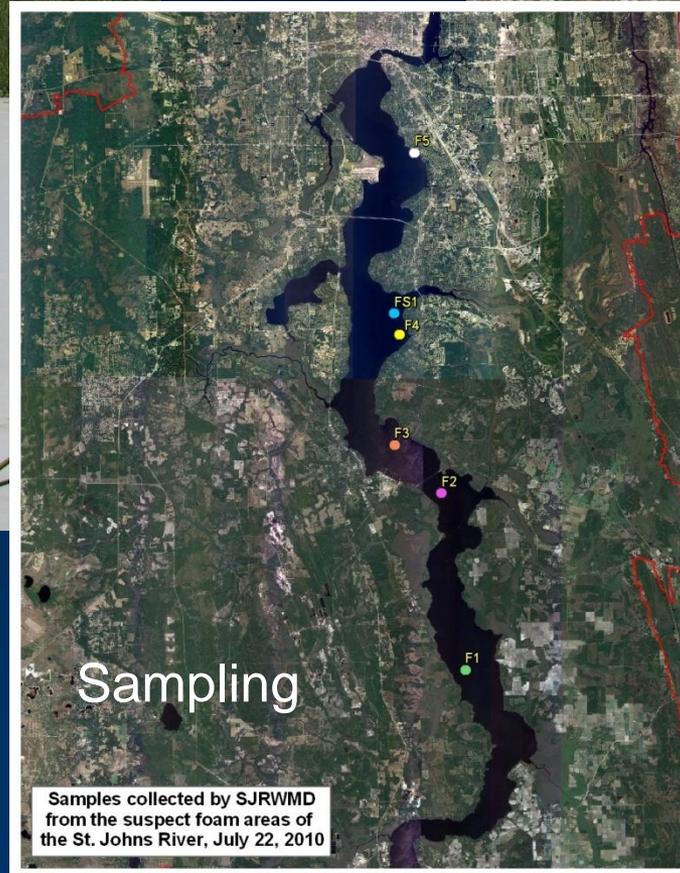
# Wind events can cause underestimates of Microcystis blooms in satellite interpretation



# Cyanobacterial blooms and the St. John's River system.

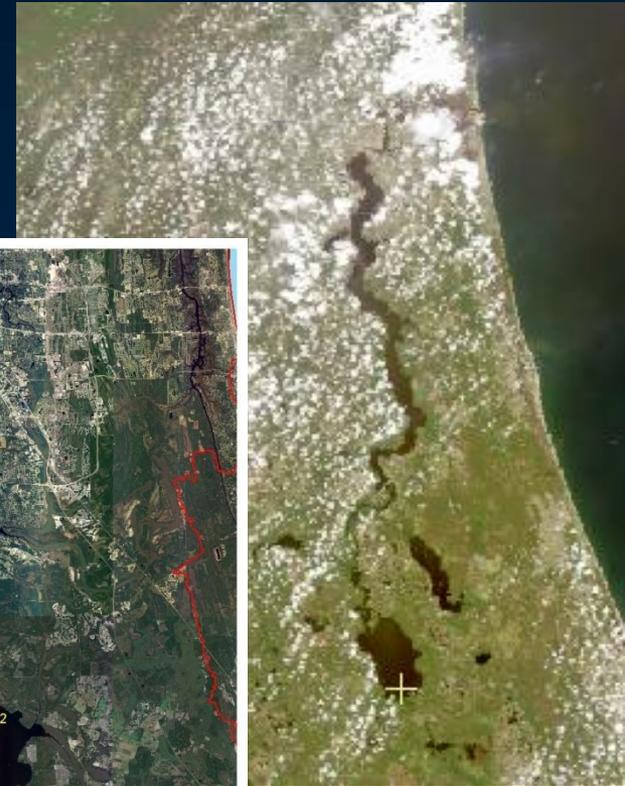


Cyano  
blooms, then  
algal Foam in  
2010



Sampling

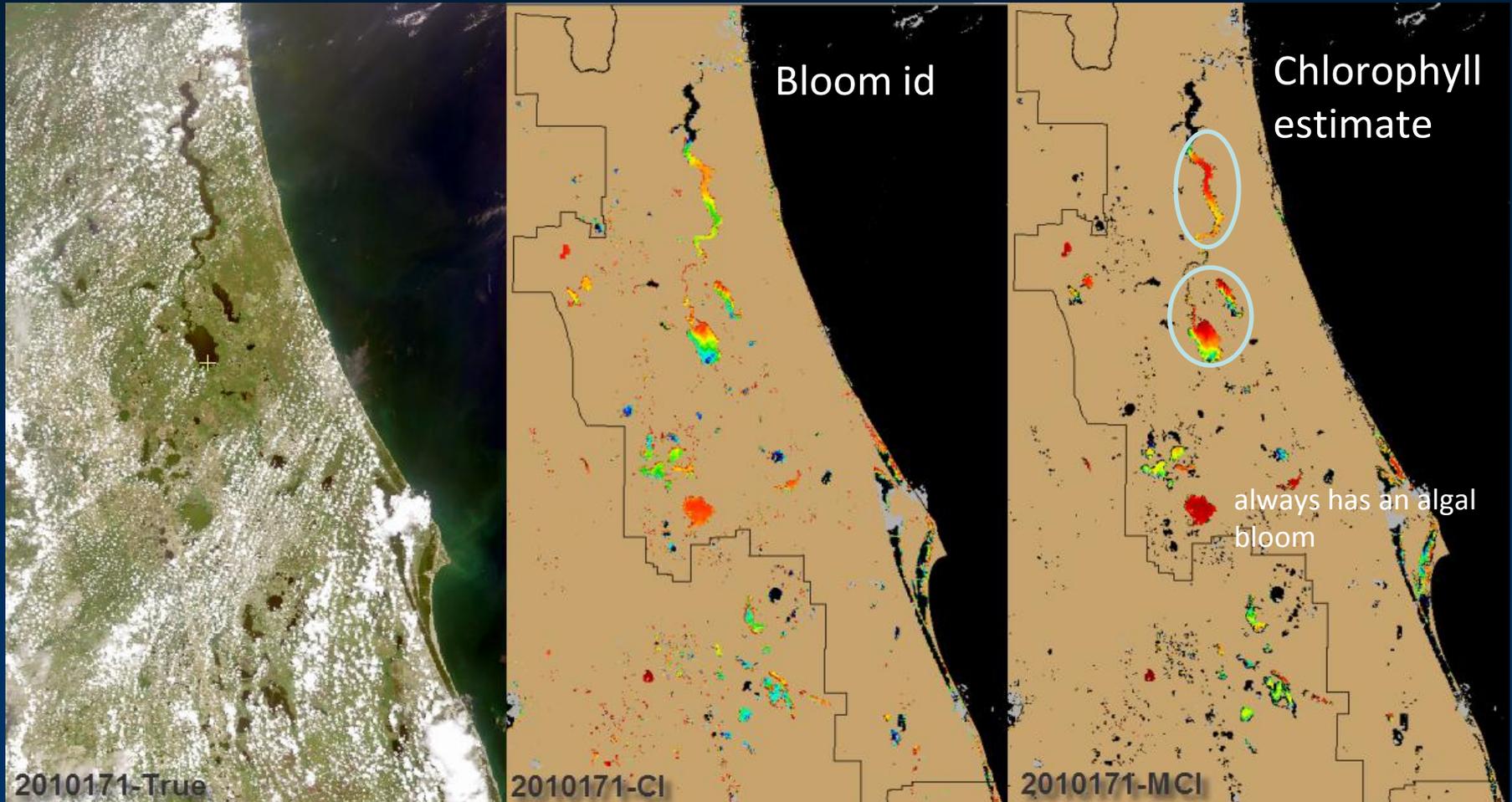
Samples collected by SJRWMD  
from the suspect foam areas of  
the St. Johns River, July 22, 2010



MERIS &  
MODIS  
Imagery

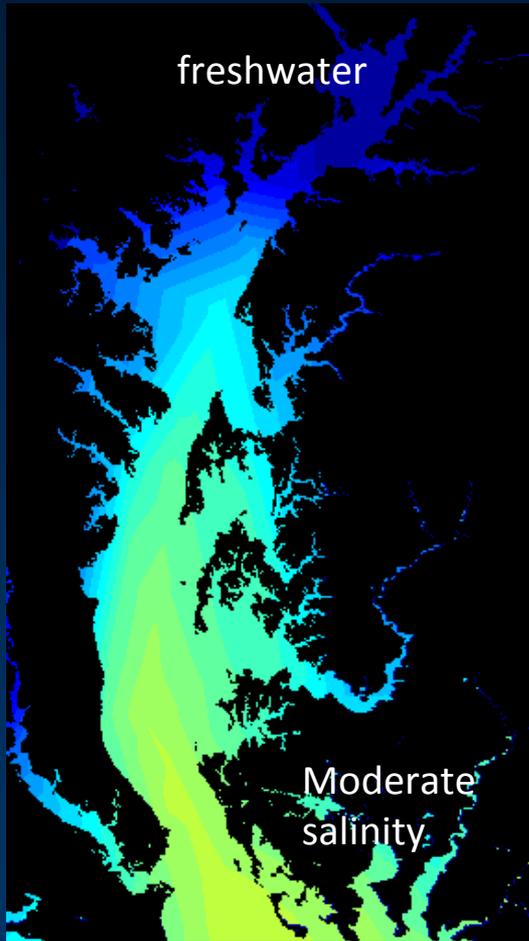
# Cyanobacterial blooms and the St. John's River system

Problem areas in  
summer 2010

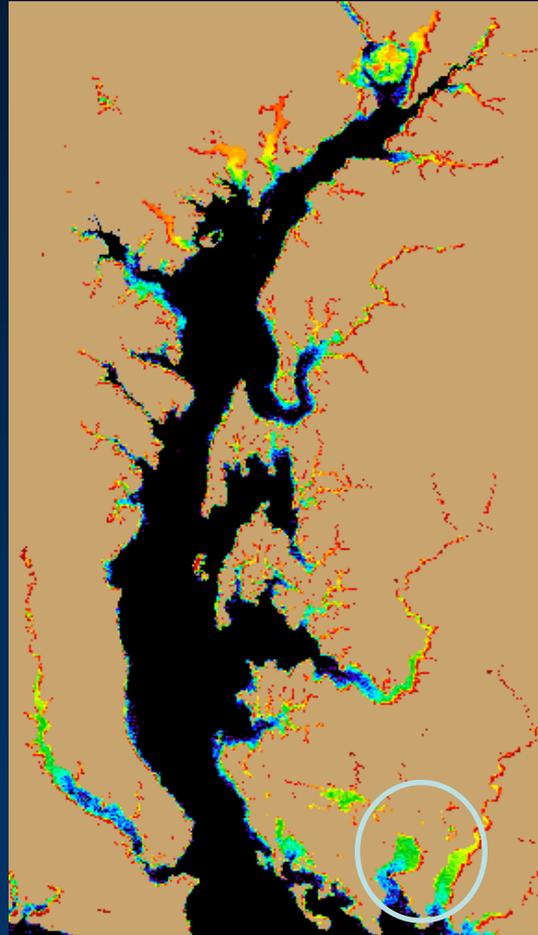


# Chesapeake analysis, identify different HABs

Salinity habitat

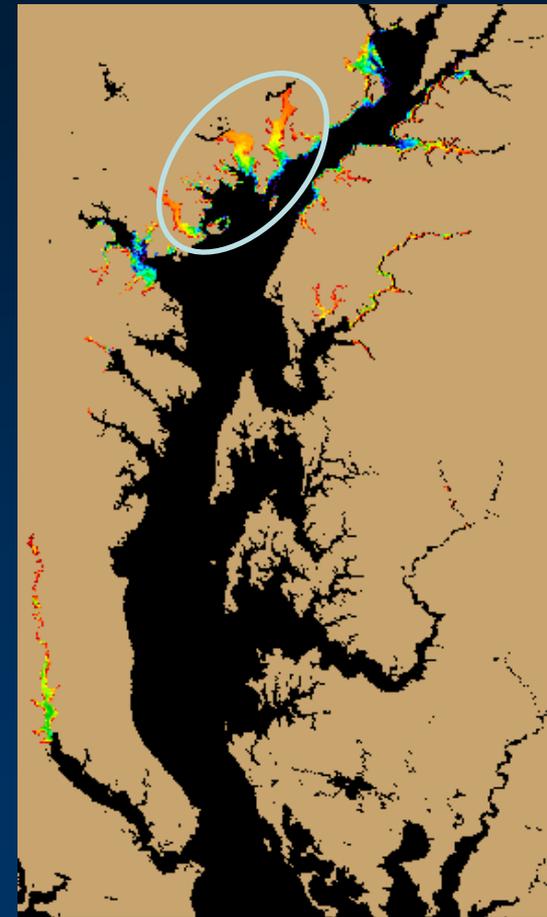


blooms



=

Low salinity: potential cyano blooms



Other species

## Year 2

**National:** Identify monitoring methods used by other states  
(through CDC HABISS)

Coordinate with CDC Environmental Monitoring (mtg in Dec)  
examine foam and scum detection

Coordinate with NASA P/ACE program for next sensor

**Florida:** Meeting with mgrs of St Johns River WMD this week,  
identify needs, especially quantitative data

**Ohio:** Continue this fall in Erie

Improve forecasts for Erie and Ohio in 2010

Work with Ohio EPA and Ohio DNR on other lakes

Implement cell count, chlorophyll numbers

Climatology of extent and frequency

**Maryland:** (New) Started evaluations for cyanos and other HABs  
in MD Chesapeake (MD DNR, MD Dept Health).

# Metrics

Metric	Measures		
<b>Total forecasts</b>	Ohio monitor: FL, MD	multiple	0-3 day OH
<b>Use of forecasts</b>	100 subscribers OH < 6 FL 10 MD	OH: multiple MD: multiple FL: multiple	2 products OH 1 product MD 1 product FL
<b>Data access # agencies contributing</b>	OH, 3 MD, 3 FL, 1	multiple	# data records in HABISS, pending
<b>Response plans</b>	Under development	OH yes MD yes	# changes in response
<b>Skill</b>	Assessibility: weekly	% accuracy, pending	% increase in accuracy during project
<b>Outreach/ education</b>	Training in OH	Several agencies	# of individuals, 16 OH
<b>Reliability</b>	% of products created each season	% products assessed each year	% of users engaged each year